

Whitefly Infestation and Economic Comparison of Two Different Pest Control Methods on Soybean Production

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ABSTRACT

Insecticide application is a common practice done by farmers to control the whitefly *Bemisia tabaci*. While the use of insecticide can suppress the whitefly population, the cost of soybean production is also increased. The objective of this research was to compare the whitefly infestation and economic of two whitefly control methods on soybean production. Two sets of experiments were done, one set with insecticide application and another one without insecticide application. Ten soybean cultivars were used in each set of experiment with completely randomized design and three replications. The whitefly infestation was observed weekly on sample plants on each plot. The benefit and R/C ratio were calculated based on revenue and total costs of soybean production. The average whitefly (egg and nymphs) population on the plots with insecticide application was 4.95 for egg and 5.72 for nymph per leaf, which was lower than those without insecticide application 11.76 for egg and 10.86 for nymph per leaf. The average benefit and R/C ratio for the plots with insecticide application were IDR 9,654,507/ha and 1.51 respectively, while the average benefit and R/C ratio for the plots without insecticide application were IDR 8,706,299/ha and 1.55 respectively. The study can be concluded that growing soybean without insecticide treatment was more efficient than growing soybean with insecticide applications.

Keywords: *Bemisia tabaci*, Insect pest, Insecticide, Soybean cultivars

ABSTRAK

Aplikasi insektisida biasanya dilakukan oleh petani untuk mengendalikan kutu putih *Bemisia tabaci*. Penggunaan insektisida dapat menekan populasi kutu putih, biaya produksi kedelai juga meningkat. Tujuan dari penelitian ini adalah untuk membandingkan metode pengendalian hama terhadap kutu putih dan nilai ekonomi pada produksi kedelai. Percobaan dilakukan dengan dua faktor, faktor pertama yaitu aplikasi insektisida dan aplikasi tanpa insektisida. Faktor kedua yaitu sepuluh kultivar kedelai. Percobaan disusun dengan rancangan acak lengkap dan tiga ulangan. Kutu putih diamati setiap minggu pada tanaman sampel pada setiap plot. Keuntungan dan Rasio R/C dihitung berdasarkan pendapatan dan biaya total produksi kedelai. Populasi kutu putih (telur dan nimfa) rata-rata pada plot dengan aplikasi insektisida adalah 4,95 untuk telur dan 5,72 untuk nimfa per daun, yang lebih rendah daripada yang tidak memiliki aplikasi insektisida 11,76 untuk telur dan 10,86 untuk nimfa per daun. Rata-rata keuntungan dan rasio R / C untuk plot dengan aplikasi insektisida masing-masing adalah Rp 9.654.507 / ha dan 1,51, sedangkan rata-rata keuntungan dan rasio R / C untuk plot tanpa aplikasi insektisida masing-masing adalah Rp 8.706.299 / ha dan 1,55. Dari penelitian dapat disimpulkan bahwa tumbuh kedelai tanpa perlakuan insektisida lebih efisien dibanding menanam kedelai dengan aplikasi insektisida.

Kata kunci: *Bemisia tabaci*, Serangga hama, Insektisida, Kultivar kedelai

INTRODUCTION

One of the problem in soybean production is pests and diseases. The whitefly *Bemisia tabaci* Gennadius, is an important pest that cause significant yield loss of soybean cultivation in Indonesia. Whitefly attack can reduce soybean production up to 80%, moreover in severe attack can cause a crop failure. Whiteflies can lead to damage either directly or indirectly (Hoodle 2013). Direct damage occurs when the stylet from whiteflies pierce the leaves and suck sap that causes chlorosis in plants (Gulluoglu *et al.* 2010). Nymphs and adult suck the sap from the

leaves causing damage to several crops particularly Asteraceae, Compositae, Crucifera, Cucurbitaceae, Euphorbiaceae, Fabaceae, Labiatae, Leguminosae, Malvaceae and Solanaceae (Bayhan *et al.* 2006). While the indirect damage occurs due to the accumulation of honey dew that attract the sooty mold to growth on the entire surface of the leaf and disrupt the process of photosynthesis (Hilje and Morales 2008). In addition, the whiteflies are also known play role as vectors of viral disease *Cowpea mild mottle virus* (CPMMV), *Blackeye cowpea mosaic virus* (BICMV), *Bean yellow*

mosaic virus (BYMV), *Soybean stunt virus* (SSV), *Peanut stripe virus* (PStV), and *Soybean mosaic virus* (SMV) on soybean plants (Marwoto and Inayati 2011).

Chemical control is the main option selected by farmers to controlling *B. tabaci* in the field. Consequently, chemical control has been used extensively in *B. tabaci* management (Horowitz & Ishaaya 1996). Selecting more effective insecticides and using them in rotation or combination is necessary. The side effect of insecticide application were killed non-target species, contaminate the environment, and leave a dangerous residue. The control of whiteflies using chemical method has not given a significant result to decrease the population of *B. tabaci* (Palumbo *et al.* 2001). According to Norris *et al.* (2003) this was related to a new strain of whiteflies that easily formed because of intensive pesticides application. The objective of this research was to compare the whitefly infestation and economic of two whitefly control methods on soybean production.

MATERIALS AND METHODS

Field experiment were conducted at Indonesian BALITKABI research station in Ngale, Ngawi District, East Java. Soybean cultivars used in the experiment were Dena 1, Devon 1, Demas, Detam 3, Grayak 1, Dewah, Gema, Anjasmoro, Dering and Wilis. The field experiment was conducted in the dry season from July to September 2016.

Population Dynamics of *Bemisia tabaci*

Each cultivar of soybean was planted on a plot measuring width of 4 m and length of 20 m, and laid out as completely randomized design with three replications. There were two sets of experiments, one set with insecticide treatments and another set without insecticide treatments.

The insecticide used are Sipermetrin 100 g/l, Deltametrin 25 g/l, Klorpirifosfuazuron 50 g/l, Fipronil 50 g/l and Beta Siflutrin 25 g/l. The total of plots in the two sets of experiments are 60 with the size of each plot is 80 m². Planting spacing used was 40 cm between rows and 20 cm within rows, two plants per hole. In this study, there were no artificial infestations of whiteflies, but whiteflies allowed to attacking naturally. Three percent (Twenty three) plants from each plot and two leaves from each plant (medium and upper parts) were obtained for investigation of whitefly population. Eggs and larvae numbers were determined on the leaves. Observations of whitefly population were conducted every week from 1-10 week after planting (WAP).

Productivity, Benefit and R/C Ratio of Soybean Farming

For the calculation of the percentage reduction in soybean yields due to the attack whiteflies, then a set of the same study conducted in the same time and same location, but separate from the experimental plot without insecticide application with performed pest control optimally including whiteflies. Pest control on this plot carried out by spraying insecticide once a week from 2-9 week after planting. Observation were carried out on yield soybean production per plot.

Production cost are all cost incurred for the production of soybean farmers during one growing season. Farmers revenue is derived by multiplying production of soybean with the selling price of soybean (Soekartawi 1995). To calculate the revenue can use the formula:

$$TR = Y \times P_y$$

TR = Total Revenue

Y = Soybean production in one growing season

P_y = Selling price of soybean

The profit is the difference between revenue and production cost. Profit can be calculated using the formula:

$$\pi = TR - TC$$

$$\pi = \text{Profit}$$

TR = Total Revenue

TC = Total Cost

According to Rahim and Hastuti (2007) analysis of the ratio R/C is a comparison between revenue and production costs. The analysis can use the formula:

$$R/C \text{ Ratio} = TR / TC$$

$$TR / TC > 1 = \text{Profit}$$

$$TR / TC < 1 = \text{Loss}$$

$$TR / TC = 1 = \text{Equal}$$

Data Analysis

The data obtained was statistically analyzed using SPSS 17 software.

RESULTS AND DISCUSSIONS

Population Dynamics of *Bemisia tabaci*

Table 1. Whitefly Egg Number of Two Treatments on Ten Soybean Cultivars

Cultivars	Mean of egg number		P Value
	Without Insecticide	With Insecticide	
Dena	1.5	0.86	0.376
Devon	10.9	3.47	0.270
Demas	2.58	4.70	0.257
Detam	0.61	0.56	0.747
Grayak	5.45	3.95	0.433
Dewah	3.46	0.79	0.187
Gema	0.47	0.31	0.493
Anjasmoro	2.89	0.72	0.167
Dering	0.37 b	0.64 a	0.03
Wilis	0.62	0.54	0.822

Note: Numbers in the same row are not followed by the same letters are significantly different (Independent T Test, P = 0.05).

The whitefly population level was relatively low in insecticide treatment than without insecticide treatment (Table 1 and Table 2). On insecti-

cide treatments, the population increase still occur even applied insecticide every week (Figure 1 and Figure 2). But the magnitude of the increase in population is not as big as in the experimental plots without insecticide application. The low susceptibility of the whitefly to many insecticides and the reduction of its natural enemy populations, because of applications of non-selective compounds, are factors that have contributed to the increase in the whitefly population in area with insecticide treatment (Byrne and Devonshire 1997).

Table 2. Whitefly Nymph Population of Two Different Treatments on Ten Soybean Cultivars

Cultivars	Mean of egg number		P Value
	Without Insecticide	With Insecticide	
Dena	3.51	1.73	0.078
Devon	14.48	9.02	0.379
Demas	5.57	11.17	0.114
Detam	1.79	1.98	0.733
Grayak	11.33	12.00	0.893
Dewah	5.90	1.74	0.122
Gema	1.52	1.31	0.739
Anjasmoro	5.02	3.02	0.397
Dering	2.10	2.78	0.287
Wilis	2.75	2.55	0.871

Note: Numbers in the same row are not followed by the same letters are significantly different (Independent T Test, P = 0.05).

B. tabaci has attacked soybean since 2 WAP (Second trifoliolate). The population of *B. tabaci* continue to increase in the egg phase until 7 WAP (beginning pod development), however the nymph phase until 8 WAP (full pod). The increase occurred due to abiotic factor such as temperature. The average temperature during July, August and September were 33.82 °C, 31 °C and 31.77 °C respectively. According to Butler *et al.* (1983) *B. tabaci* needs temperature higher than 26 °C and 60% relative humidity for optimum development. Egg population was decreasing at 8 WAP. This was because the soybean plants stop growing and did not form new leaves.

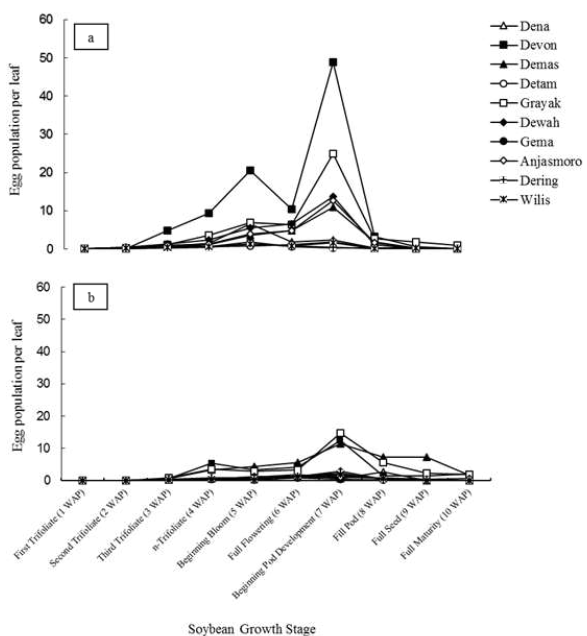


Figure 1. Population Development of *B. tabaci* Eggs Per Leaf on The Treatment Without Insecticide (a) and With Insecticide (b)

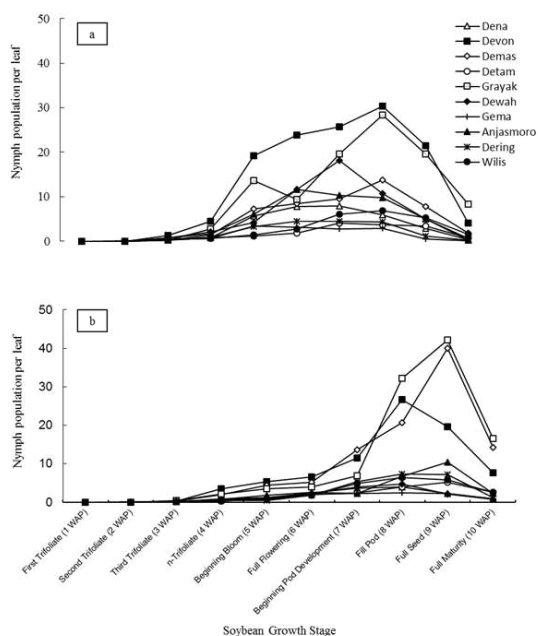


Figure 2. Population Development of *B. tabaci* Nymph Per Leaf On The Treatments Without Insecticide (a) and With Insecticide (b)

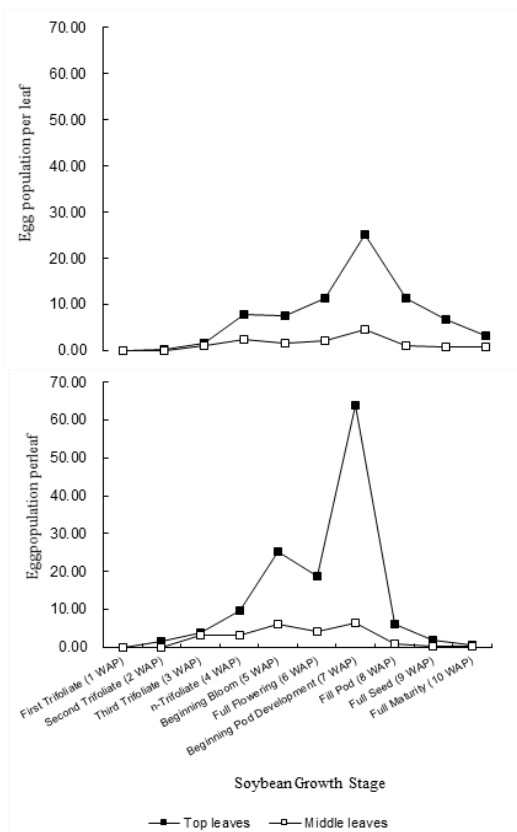


Figure 3. *B. tabaci* Oviposition Preferences Based On The Position Of Leaves On Insecticide Treatment (a) and Without Insecticide Treatment (b)

Soybean cultivars with determinate growing type stop growing when the plants are in the full flowering stage. An abiotic factor such as rainfall also affected the populations of *B. tabaci*. The average rainfall at 8 to 10 WAP (pods maturity) was approximately 15.95 mm. Arif *et al.* (2006) found that rainfall is negatively correlated with populations of *B. tabaci*.

The whitefly eggs were the most abundant on the top leaves (Figure 3). According to Gamel (1974) *B. tabaci* tend to lay eggs on young leaves are caused by nutritional choices to eat and breed.

Soybean Productivity

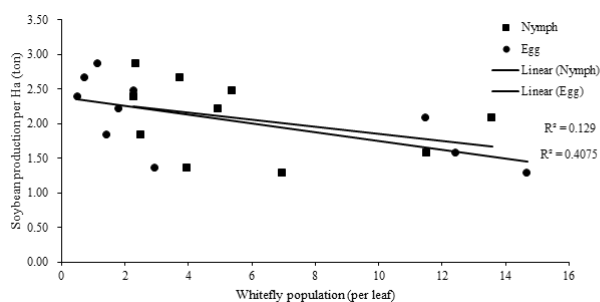


Figure 4. Correlation between *B. tabaci* population and soybean production in plot with insecticide treatment

The result of this experiment showed that the insecticide application did not have significant effect on the productivity of soybean. Bueno *et al.* (2011) found that the prophylactic use of insecticide in the soybeans does not lead to higher productivity in the field when compared with the technique of Integrated Pest Management (IPM) and biological control. This show that the insecticide application should be used based on the economic threshold. There were correlation between population of the whitefly *B. tabaci* (eggs and nymphs) and soybean production (Figure 4 and Figure 5).

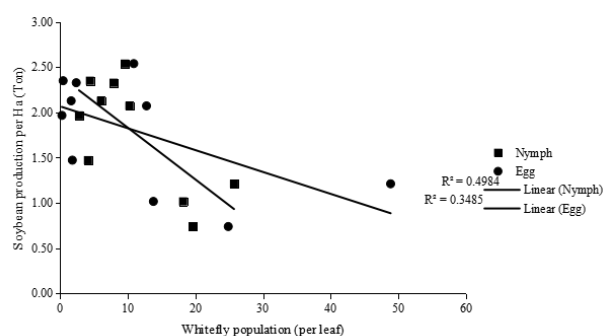


Figure 5. Correlation between *B. tabaci* population and soybean production in plot without insecticide treatment

Highpopulation of *B. tabaci* definitely caused the lower of soybean productivity. It is caused by the damage of the leaves due to this pest feeding activity. Arifin and Rizal (1989) stated that the decrease in yield components such as number of pods and number of seeds caused by the death of the flowers and young pods due to reduction of photosynthesis capacity caused by leaf damage.

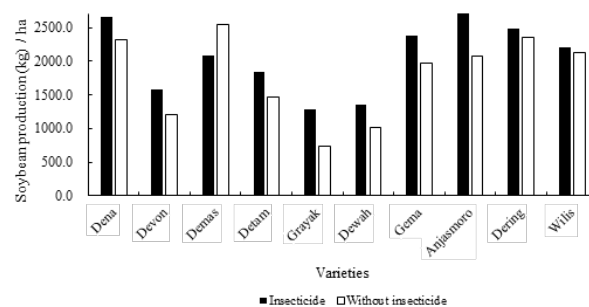


Figure 6. Productivities of 10 soybean cultivars/Ha

In general, soybean growth with insecticide application have greater yield than the soybean without insecticide application (Figure 6), although it did not significantly different. The Demas cultivar had a higher productivity on the plot without insecticides compared to the plot with insecticide treatment. This indicates that the application of insecticides is not always giving a positive influence in the productivity.

Application of insecticides should be based on the observation of pest population.

Benefit and R/C Ratio of Soybean Farming

Soybean production costs with insecticide application was Rp. 18 785 333 and without insecticide application was Rp. 15 760 000 per Ha. While soybean production with insecticide application was 3 977.6 kg and without insecticide application was 3 421.6 kg per Ha. With the selling price of soybean was Rp. 7 150, the revenue were Rp 28 439 840 and Rp. 24 466 299, respectively. The profit were Rp. 9 654 507 and Rp. 8 706 299 respectively. The R/C ratio was 1.51 for growing soybean with insecticide and 1.55 without insecticide. The ratio of R / C means that the cost of Rp. 1.00 will receive a profit of Rp. 1.55 for growing soybean without insecticide. While on the insecticide treatment, the cost of Rp. 1.00 will receive a profit of Rp. 1.51. In other words, in the experiment showed that growing soybean without insecticide treatment was more efficient than growing soybean with insecticide applications. Soekartawi (1995) states that efficient is the comparison of the efforts by the results achieved.

CONCLUSION

Insecticide application can decrease the population of the whitefly, *B. tabaci* on the soybean field, but did not always increase the yield significantly. In certain level of the whitefly population, growing soybean without insecticide was more efficient than that with insecticide treatment.

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